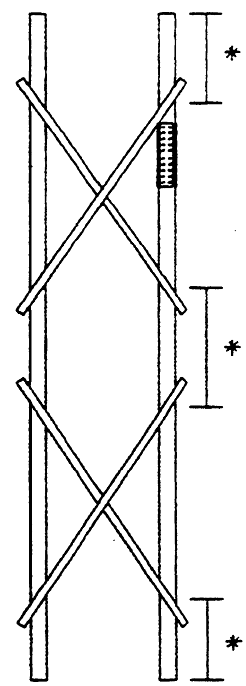
SPLICING OF FALSEWORK POSTS

Timber falsework posts may be spliced. The guidelines contained herein shall be used to analyze properly located post splices.

Splice plates shall be assumed to act in pairs, one on either side of the post. Plates are required on all sides of the post since horizontal loadings can act in any direction. Minimum length of splice plates shall be 4 times the maximum post width (48 inches for 12" x 12" posts) and the splice plates shall be centered. The minimum thickness of splice plates for 12" x 12" posts shall be 2 inch nominal lumber.

Splices shall only be located on posts between upper and lower ends of the members making up- an X-brace. Post splicing shall not be located where it can be assumed that moment will be induced into the post or splice plates, as at upper and lower post ends beyond bracing limits, or between pairs of X-braces, as indicated by the * in the figure to the right.



Longitudinal bracing will often have a different configuration than the transverse bracing. Use the longest unbraced length.

The figure to the right assumes transverse bracing with no longitudinal bracing, or with longitudinal brace connections matching the uppermost and lowermost transverse brace connections. Post splices, for posts braced both transversely and longitudinally, must be located within the post length between points of restraint (or brace connection locations) of both transverse and longitudinal pairs of X-brace connections.

Metal banding (strapping) offers no apparent structural restraint and may not be used as a substitute for nails.

The following criteria is to be used for analyzing splices:

1. Determine the post loading. The vertical post load will be the sum of all dead (excluding post weight) and live loads. If the post is to support falsework

over traffic the load used shall be the greater of the following:

(1) 150 Percent of the design load, or

(2) The increased or readjusted loads caused by the prestressing forces.

2. Determine the longest unsupported, or unbraced length, of post between points of restraint considering both transverse and longitudinal directions.

3. Verify that the post is not overstressed for the longest unbraced length condition.

4. Determine the smallest theoretical post which will meet the design vertical load for the longest unsupported length. This theoretical post will be smaller than the actual post, but will still have to meet the stress requirements outlined in 3 above.

5. Determine the section modulus required for the splice plates based on the smallest theoretical post size, but which are to be installed on the actual post.

6. Apply a fictitious load equivalent to 0.75% of the total vertical post load normal to the axis of the post and splice plates for a splice hypothetically located midway between the most widely spaced points of restraint.

7. Evaluate horizontal shear using only the side plates.

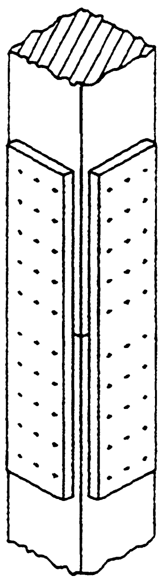
8. Determine the number of nails required. The number of nails required is determined from the force induced in the cover plates from the fictitious loading. Verify a minimum of 11 diameters penetration in the post or use reduced values for lesser penetration. Load duration factors for splice plates shall not exceed 1.0.

   Physical testing at the Transportation Laboratory has indicated that nail resistance equal to twice the normal permitted value for lateral loading-may be used for splice plate connections.

An example problem demonstrating the analysis of square post splicing follows:

EXAMPLE PROBLEM:

This example problem consists of 2 parts, the purpose of which is to demonstrate the analysis of two separate posts which are to be spliced.



Posts: 12" x 12": Unsupported 12 feet transversely and 20 feet longitudinally.

Splice located near mid-height of single X-braced post.

Splice plates: 2" x l0" x 4'-0" each side of post with 15 - 16d duplex nails in each half of the splice.

Good workmanship with full bearing and with no built in eccentricity is required.

PART l. Post No. 1: Load = 55,000 Lbs. Post is adjacent to, and supporting falsework over traffic.

PART 2. Post No. 2: Load = 92,500 Lbs. Post not adjacent to, nor supporting falsework over traffic.

PART 1. Analysis of Post No. 1

1. Determine load on post adjacent to traffic:

Load = 150%(55,000) = 82,500 Lbs

Determine section modulus of post and compare to required:

$$S = \frac{bd^2}{6} = \frac{(12)(12)^2}{6} = 288 > 250\ in^3 \qquad OK$$

2. Longest distance between laterally restrained points equals 20 feet in the longitudinal direction. Use longest unbraced length = 20 feet.

3. Verify that the post is not overstressed for the longest unbraced length.

Determine the allowable stress based on unbraced length:

$$\frac{480{,}000}{\left(\frac{L}{d}\right)^2} = \frac{480{,}000}{\left[\frac{20(12)}{12}\right]^2} = 1{,}200 < 1{,}600 \text{ psi}$$

Determine stress in post due to vertical load:

$$\frac{82{,}500 \text{ Lbs}}{144 \text{ In}^2} = 573 < 1{,}200 \text{ psi}$$

4. Determine the minimum post dimensions required by the maximum post loading. The minimum post dimensions will be those of a square post which is capable of carrying the applied vertical load. This may be determined by equating f_c to F_c:

$$f_C = F_C$$

P = (55,000)(1.5) = 82,500 Lbs; L = (20) (12) = 240 inches

$$\frac{P}{A} = \frac{480{,}000}{\left(\frac{L}{d}\right)^2} \quad \text{where } A = d^2$$

$$\frac{P}{d^2} = \frac{480{,}000d^2}{L^2}$$

$$d = \left[\frac{PL^2}{480{,}000}\right]^{1/4} = \left[\frac{(82{,}500)(240)^2}{480{,}000}\right]^{1/4} = 9.97 \text{ inches}$$

5 . Compare minimum post section modulus to section modulus developed by splice plates.

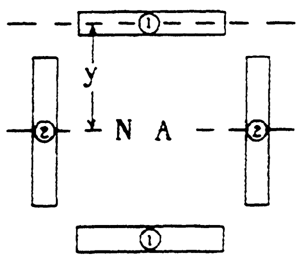
Minimum post section modulus (S):

$$S = \frac{bd^2}{6} = \frac{d^3}{6} = \frac{(9.97)^3}{6} = 165 \text{ in}^3$$

Check against section modulus of planned splice plates.

Calculate splice plate section modulus for plates installed on a full dimensional post.

Splice plate section modulus:



2 x 10 Plates	A	y	Ay^2	I_o	I
1	13.875	6.75	632	2.6	635
1	13.875	6.75	632	2.6	635
2	13.875	0	0	98.9	99
2	13.875	0	0	98.9	99
					1,468 in^4

$$S = \frac{1{,}468 \text{ in}^4}{7.5 \text{ in}} = 195.7 \text{ in}^3 > 165 \text{ in}^3$$

A section modulus of 250 in^3 is the minimum post section modulus required for a post adjacent to traffic. This splice is not acceptable for use on a post adjacent to traffic since the net section modulus of the splice plates (195.7 in^3) is less than the 250 in^3 minimum wood section modulus specified in Section 51-l.O6A(3), Special Locations, of the Standard Specifications.

The proposed splice for Post No. 1 as submitted cannot be used for the p&pose intended.

PART 2. Analysis of Post No.2

Post No. 2 will be analyzed for a load of 92,500 pounds. This post is not adjacent to, nor is it supporting falsework over traffic; therefore, no section modulus requirements are specified for an unspliced post at this location. However, the splice plates will need to develop the theoretical minimum post section modulus.

1 . Post loading not adjacent to traffic condition = 92,500 LbS.

2 . Longest distance between lateral restraint points = 20 feet.

3 . Determine the allowable stress based on unbraced length:

$$\frac{480{,}000}{\left(\frac{L}{d}\right)^2} = \frac{480{,}000}{\left[\frac{20(12)}{12}\right]^2} = 1{,}200 < 1{,}600 \text{ psi}$$

Determine stress in-post due to vertical load:

$$\frac{92{,}500 \text{ Lbs}}{144 \text{ In}^2} = 642 < 1{,}200 \text{ psi}$$

4. Determine the minimum post dimensions required by the maximum post loading. The minimum post dimensions will be those of a square post which is capable of carrying the applied vertical load. This may be determined by equating f_c to F_c:

$$f_c = F_c$$

$$P = 92{,}500 \text{ Lbs}; \quad L = (20)(12) = 240 \text{ inches}$$

$$\frac{P}{A} = \frac{480{,}000}{\left(\frac{L}{d}\right)^2} \quad \text{where } A = d^2 \quad \therefore \frac{P}{d^2} = \frac{480{,}000d^2}{L^2}$$

$$d = \left[\frac{PL^2}{480{,}000}\right]^{1/4} = \left[\frac{(92{,}500)(240)^2}{480{,}000}\right]^{1/4} = 10.26 \text{ inches}$$

5 . Compare minimum post section modulus to section modulus developed by splice plates.

Minimum post section modulus (S):

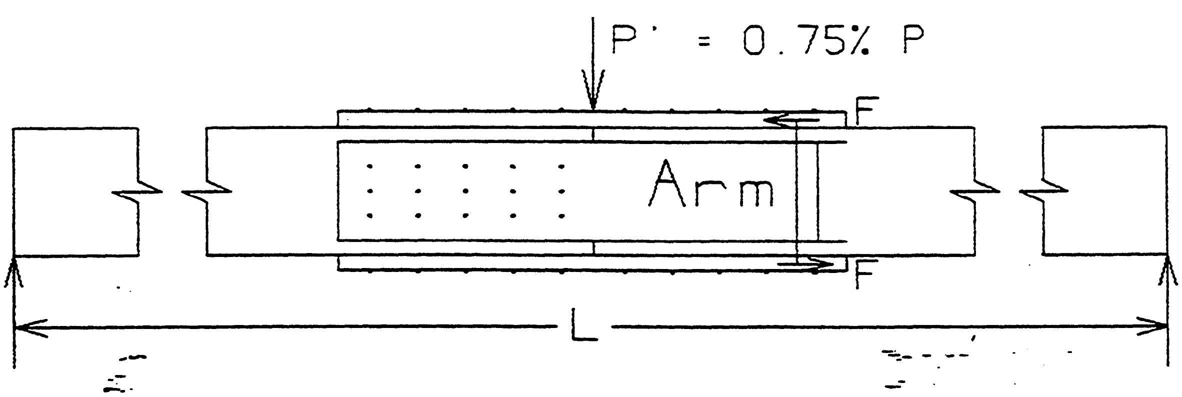
$$S = \frac{bd^2}{6} = \frac{d^3}{6} = \frac{(10.26)^3}{6} = 180 \text{ in}^3$$

Check against section modulus of planned splice plates.

The section modulus of the splice plates is the same as determined for the post in Part 1: 195.7 in^3 > 180 in^3. The section modulus of the splice is satisfactory for this post loading at this location.

6 . Apply a fictitious lateral load (P') equivalent to 0.75% of the post loading (P) normal to the post-axis at the post splice location hypothetically centered between restraint points).

Lateral load: P' = 0.75%(92,500) = 694 Lbs.



From the rotated post depicted in the previous figure, the top and bottom splice plates will be referred to as 'cover plates', with the other two splice plates referred to as 'side plates'.

3. Evaluate the side plates for shear. Only the side plates are to be considered for shear resistance.

$$\textbf{Shear} = P'/2 = 694/2 = 347\ \textbf{Lbs.}$$

Horizontal Shear:

$$v = \frac{3V}{2A} = \frac{3(347\ \text{Lbs})}{2(2\ \text{plates})(13.875\ \text{in}^2/\text{plate})} = 19 < 140\ \text{psi}\quad \text{OK}$$

8 . Determine number of nails required.

The required number of nails in each half of a splice plate is to be determined in the following manner:

a. Determine end reactions (V) of a beam equivalent to the longest unrestrained length (L) loaded centrally with a fictitious concentrated load (P') equal to the applied lateral load. This assumes the splice is located centrally between the largest spaced points of lateral restraint (longest unbraced length).

$$V = P'/2$$

b. Determine the moment at the center of the splice.

$$M = V(L/2) = P'/2(L/2) = P'L/4$$

c. Determine length of a resisting moment couple arm of forces (F) between the centers of thickness of the cover plates. Arm = post width + 2(1/2)t of the splice plates. For a 12" x 12" post with 2" cover plates:

$$\text{Arm} = 12 + 2(1/2)1.5\ \text{Inches.}$$

d. Determine F by dividing the moment determined in part b above by the couple moment arm determined in part c above.

$$F = (P'L/4)/\text{Arm}$$

e. Determine the lateral load resistance value of one nail in a cover plate. This value may be doubled for splice plate usage.

f. Number of nails required then equals the force (F) divided by the value of one nail for lateral loading.

No. of Nails = F/Nail Value (round up)

a. Reaction V = 694/2 = 347 Lbs.

b. Moment M = 694(20)/4 = 3,470 Ft-Lbs.

c. Arm = 12 + 2(1/2)1.5 = 13.5 Inches.

d. Force F = M/Arm = 3,470(12 In/Ft)/l3.5

= 3,084.4 Lbs.

e. NDS Nail value is doubled:

Desired penetration of 16d nail = 11d = 1.78 In.

Actual penetration of 16d = 3.125 - 1.5 = 1.625 In.

Nail value must be prorated.

Nail value for full 11d penetration = 108 Lbs.

Nail value for min. of 0.59 Inches = 36 Lbs.

Prorated nail value:

$$\text{Nail value} = 2\left[36 + \frac{1.625 - 0.59}{1.78 - 0.59}(108 - 36)\right]$$

$$= 2[36 + (0.8697)(72)]$$

$$= 2(98.62)$$

$$= 197 \text{ Lbs/nail}$$

f. Number of 16d nails required:

$$\text{Nails required} = \frac{3{,}084.4 \text{ Lbs}}{196 \text{ Lbs/Nail}} = 16 > 15$$

The proposed splice is not acceptable since the number of 16d nails provided is less than the number required.

For curious comparison, determine the number of 20d nails that would have been required.

Desired penetration of 20d = 2.11 inches.

Actual penetration = 3.625 - 115 = 2.125" OK

Nail value for 20d nail = 139 Lbs.

$$\text{Nails required} = \frac{3084.4 \text{ Lbs}}{2(139 \text{ Lbs/nail})} = 12$$

The design splice plates will be satisfactory for the maximum unbraced length, for the post loading, and for the location of intended use with a total of either 16 or more 16d duplex nails or 12 or more 20d duplex nails per each half of each splice plate.

It will be necessary to verify that splices will not be located on unbraced portions of posts, as at upper and lower post ends beyond bracing limits, or between pairs of X-braces where moments might occur.